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A SLAVE-MAKING FORAY OF THE SHINING AMAZON (POLYERGUS LUCIDUS MAYR).

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The following observations were made on the afternoon of July 21, 1903, during the session of the Yale Summer School of Forestry on the estate of Grey Towers, owned by Mr. James W. Pinchot, Milford, Pike Co., Pa. The slave-holding colony was situated within a few yards and down hill from the camp street, formed by two rows of tents, located on a sandy shoulder of the shale hills, rising in irregular terraces from the broad inner vestibule made by the Sawkill River before entering the gap it has cut through the western palisades of the Delaware River. The altitude of this shoulder or terrace cannot be over 900 feet above sea level. The terrace faces the east, is slightly mounded, and has an inclination towards the south as well. It is turfed in places, sandy in others, and towards the south becomes wet land and wooded. On the steep east slope the friable shale outcrops immediately, and it is near this point that the nest was located.

The workers who go forth to war are of one general color — a deep red, varying from mahogany to cherry red, almost a deep blood red in certain lights, and as shiny as chitin armor can make them. They are of the size of the black slave ant, *Formica fusca* var. *subsericea*, about one quarter inch long, and a little larger than the slave-maker I have usually observed, namely, *Formica sanguinea*, subsp. *rubicunda* var. *subintegra*, in North Brookfield, Mass.

My attention was called to them at 2:30 p. m., just as the army was crossing our camp street, going in a direction due WSW. The cloudy morning had given way to a noon of sunshine and heat, and now these ants appeared, a shining stream of blood red, swiftly slipping over the scant, gravelly turf, their chitin armor glistening in the hot sun like rolling jewels. They formed a living squadron with a width of less than five inches and a length of eighteen to twenty-four inches, regular enough in formation to be enclosed in a parallelogram of such dimensions. This doughty detachment, reckoned at 200 or more by three other observers who witnessed this part of the tactics

(Barrington Moore, Yale, '06; Robert Allen, Erie High School, '02; and Daniel G. Saunders, Harvard, '04), had left behind them only three or four stragglers in a distance of over a rod of the rear trail, and in the next ten minutes rushed on impetuously in a nearly straight line for eighty-five feet more.

The three or four stragglers could barely gain on the main column, for the latter was going at breakneck speed, without any advance guard or advance formation for driving in the enemy, as the *sanguinea* slave-makers do at a much lower rate of speed. Yet it was evident that the ground passed over was as well covered by this flying detachment as by the *sanguineas* with their mushroom-shaped advance, two to four feet in width. Neither species has been seen to ascend grass blades, but both swarm over flat leaves, low grass stubble, stones and rubbish accumulations, without paying much attention to the invasion of holes of nearby insects. Thus the stragglers were plunging along, heads down, just as fast as couriers (or, perhaps, badly frightened ants) ever go in the battles of the *sanguineas*, trying almost vainly to catch up.

The army passed directly over or across the edge of four hillocks of a smaller common ant, resembling *Prenolepis imparis*. The latter disappeared in their homes, and most of the swift-footed troop swept over their hill-tops. Yet a few always lingered to dig the *imparis* out. Thus four or five would set to work busily and excitedly excavating for foes, but two or three minutes later I saw them speeding on after the main troop. I surmise that the first stragglers I noticed may have fallen behind by pursuing similar fruitless quests. But it would be just as likely that the army set off before these stragglers had climbed out of the nest, and so were delayed in getting their bearings and following the trail. It is certain that it would be more difficult for belated ants of a *Polyergus* army to pick up the route than for *sanguineas*, for the latter are always meeting friends along the way who seem to act as an incitement to better speed, while these ants go in a close formation with a rear as compact as the van, leaving no guides *en route*, except scent. They seem to move just as close together as they possibly can and yet keep up top speed, even closer than the *sanguineas*, except when the latter are collecting in a crowd for the main assault.

Close to the goal, the army seemed to have come about a foot out of line from the direct route they had been following, making allow-

ances for slight deviations passing our tents, which delayed matters a little in their finding the entrances to the nest they were after. It was immediately noticeable when they stopped proceeding further southwest and began deploying for entrance holes. While we observers were still hunting for a nest, the soldiers seemed to be lessening in numbers until there were hardly two dozen left above ground, scouring the neighborhood in a general way over two square feet of ground. Just then, not five minutes from the time they reached this vicinity, a *lucidus* appeared with a pupa; thus giving the cue to the location of the nest holes. We quickly found the inconspicuous entrance under a tuft of grass at the side of a half-buried, flat, little stone. Down this one entrance the red ant stream had drained so quickly from view that it seemed hardly possible that the insects could have already located the nursery. Another ant followed close behind the first, then others and others, till the straggling, booty-laden, homeward caravan was at once noticeable.

The speed of this homeward column, now greatly lengthened out, was little less than the outward run. The soldiers stopped for nothing unless absolutely caught fast by obstructions. The remarkable speed in ants that are supposed to remain inactive most of each year, the lack of any pause to rearrange loads, as the *sanguineas* do, and the evident unerring instinct, struck all the observers as wonderful. Where did they store up so much untiring, indomitable energy without great exercise in preparation for it? The need of athletics in the social organization of the ants is not evident. These insects are ready for extreme exertion after eight to ten months' rest, although in the case of the queen ants we know that the wing muscles at least quickly degenerate.

About 2:43 to 2:45 p. m., the first booty-laden soldier started homeward. About 3:05 to 3:10 p. m., when the column had been streaming into the home citadel for ten minutes, apparently the last burdened ant was a rod away from the captured nest. If the expedition start be taken as 2:20 p. m., the last ant would have been over half-way home at 3:20 p. m. So the real work of the expedition was done within an hour, and the time limit for the complete operation, including the last ant, scarcely exceeded an hour.

There seemed to have been no fight. Two very much excited workers appeared around the entrance of the captured nest, evidently the species inhabiting that nest. They are larger than the slow-mov-

ing *Aphaenogaster fulva* and lighter colored — black abdomen and a lighter red-brown head and thorax — but considerably smaller than the black, slave ant, *Formica fusca* var. *subsericea*, and slenderer.*

Perhaps the most interesting part of the foray was the return of the army to the home nest. At 2:55 p. m., the slaves, of a species like that captured, were excitedly and swiftly bringing out excavated earth at the home nest, while two or three amazons ran slowly about among them. Thus not all the soldiers of a nest go on a given foray.

The returning train of *Polyergus* became slightly mixed up in crossing the wagon road ; the ants starting exactly NE, thus getting off the trail which angled to the right at that crossing, then returning nearly to the edge of the road where they started to cross, taking an ESE course which soon intersected the trail they sought. Having crossed at last they seemed to get off the trail again and beat about until into a NE direction. The succeeding ants gradually straightened out the trail till it led directly across the road and then on NE, evidently the way they had first traversed that bit of country. But there continued to be a slight confusion at the turn of the trail to cross the road. It occurred to me later that a wagon may have crossed this trail between the crossings of the in- and outgoing trips, which would of course obliterate the scent at the shallow wagon ruts. On the other hand, the *sanguineas* often get mixed up at the angles or turns they sometimes make in their trails. It seems as if this pointed to the probable limitations connected with a scented trail, for the ants seem to get a general direction in mind despite their little twists and turns to avoid obstacles and do not quickly appreciate a turn in the trail. The only refutation of this that I can think of is that the first ants that scented the trail may have faltered here in their direct advance and thus caused confusion to all succeeding individuals, — another possible limitation to the scent method of trailing.

After the trouble of finding the place to cross the road, there were two amazons with young ants in their jaws that kept in the lead by about two or four feet all the way. One of them ran straight into the nest entrance and the other ran shy about four inches to the NE of it before she quickly oriented herself and also quickly disappeared down the hole. Apparently not until four or five had arrived did the news of the success of the expedition spread. Thus it does not always happen

*The ant referred to by Mr. Burrill was evidently *Formica schaufussi* Mayr, which is the normal slave of *lucidus*. — EDITOR.

that the slaves go at once to meet the returning party, as I understand Professor Forel observed. It seems more in accordance with the idea of food-getting instincts that no great number of slaves should be interested in the expedition until they see the booty begin to come in, when many ants are stimulated to go out and get more from the same rich mine. Of course the quick return of the army prevents their going so far as the pillaged nest.

After the arrival of the first four or five amazons, the attitude of the slaves changed radically, they seemed to lose their heads completely, beginning to drag in large pebbles as if they too wished to share in the home-bringing of booty. However, I saw no pebbles finally taken into the nest. A few slaves and also three or four soldiers ran up the trail meeting the home-coming train and seemed to express joy (or excitement) rather than solicitous attention in their active antics. I saw none relieve others of the home-coming stream. From now on the amazons began to arrive in close succession, often two or three abreast, and plunged straight down the entrance of the home nest. At the same time an increasing number of the red ants and their slaves began to come to the surface. The hole, only about half an inch in diameter, soon became so crowded as to be nearly stopped up. Then I saw an amazon drop her burdensome pupa to stroke her antennæ and an outcoming amazon worker picked up the pupa and took it in, hence certainly relieving the former ant of her load. This was the beginning of a considerable change in the actions of the amazons. Up to this time no ant engaged in the expedition had been seen to stop to clean herself, the way the *sanguineas* so often do on the march, and no ant had been seen to relieve another at her work; but, with the choking of the home gateway, this exhibition of the above traits in the slave-making instincts became apparent. Two or three other amazons now stopped also to clean themselves and deposit their loads for the moment, and doing so near the entrance amidst the gathering of the greater crowd, served completely to block further expeditious work. Loose pupæ and a few larvæ were kicking under foot among the many, busy, shoving amazons and slaves. As only a few of the amazons returned without young ants, the amount of plunder was judged to be about 120 pupæ and 60 larvæ. In this condition I left them, unfortunately having to attend the school lectures.

After supper, D. G. Saunders, Jr., one of the other observers, and I measured the distance between nests as 175 feet. As we found

the amazons half-way to the pillaged nest, and they accomplished the remaining distance in ten minutes, we judged that they must have traversed the first half in ten minutes, for although the first half was uphill, it was much smoother travelling than the latter or downhill half which led through the grass. So twenty minutes seemed a fair calculation for the outward trip. This is eight and three fourths feet a minute or one and three fourths inches a second, as compared with Dr. Forel's calculation of one and one half inches a second. (Things go swifter in America!) As the ants returned heavily laden at a scarcely lessened speed, we may suppose that they were certainly good for an hour of such speed without burdens, or 525 feet in an hour. This is $525/5,280$ mile an hour or .1 mile. This would be about a mile a day of say twelve hours travel during the warm weather. The *bashi-konay* or army ant of Africa is said to advance about as fast as a man can walk, which seems slightly exaggerated, but if true, is certainly at a much greater speed than these ants display.

Compared with man, the ant may be said to be about a quarter inch long as against six feet or $288/4$ inches for man. Then, roughly, a man would have to travel 288 times as far as an ant in the same hour, or 288×525 feet (151,200 feet) or $28\frac{7}{11}$ miles an hour, a gait too rapid for most athletes! If the comparison had been made on the basis of comparative bulks or weights, it would be immensely more disproportionate to man's abilities.*

Now this human test of $28\frac{7}{11}$ miles an hour is not on level ground, but to imitate climbing grass stalks, leaves, pebbles, etc., would be for man a cross-country run over fences, hillocks, boulders, etc., uphill half the way and downhill the other half.

Further notes on the condition of the colony after the foray and during the succeeding days are summarized as follows:

At 6 p. m. no amazon was outside the nest; six slaves were bringing out earth at their accustomed nervous rate; and two *lucidus* queens—large, mahogany-red, winged, female ants—came out, sunned themselves a moment, and returned. The pillaged nest was wholly deserted.

* I did not see Professor Forel's figures until the last week of April, 1908, as given in W. F. Kirby's "Marvels of Ant Life," p. 17, where he gives the speed as $1\frac{1}{2}$ inches a second, or for man 22 miles an hour, evidently reckoning the average man at 5 ft. $4\frac{1}{2}$ in., which seems to me as much too low as my standard 6 ft. may be too high.

July 22, 10 a. m., the next day. One amazon out and about. Slaves at work but so few engaged that there was nothing to indicate a slave-keeping nest unless it were the size of the mound. Even the amazon was off the nest, and might be mistaken for some stranger ant. The mound was about three inches high with a diameter of six inches counting the entrance as a center, but was not circular, being on sloping ground and therefore in a three quarters circle plan.

Noon. The colony with the east exposure of its nest to the hot sun, was celebrating its nuptial flight, though the breeze was rather heavy and gusty. Possibly one female flew away of the large winged ants in sight, only two or three in number; but over half a dozen males flew away, and I left as many more ready to fly when I went to lunch. The males were quite unlike the females, being almost jet-black, only about half as long and many times smaller than the females. The thorax was noticeably thick, high, and black. The males were very active, frisking about much more actively than the females or workers, straddling each other's backs, but in one case only, trying to mount a female. She, however, objected, turned about and crawled down the entrance. The males sometimes amused themselves by chasing each other up grass stems and "fighting", kicking and grappling each other for right of way just out of pure frenzy.

1:15 p. m. None of the males were about, but large, heavy females were out and flying away. I saw five fly off, and counted as many more getting ready to go when I left. They were like large, juicy, glistening red currants, floating away in a scintillating blurr of wings. They did not fly upward in circles, but rose with one or two zigzags and then went directly either east or west, east bearing toward the valley and west toward the higher hills. This leads me to ask if the males of this species swarm before the females as a rule?

Some of the slaves climbed grass stalks after the sexed ants, giving them a parting brush, or, seldom, a gentle tug downward as if to dissuade them from leaving. Many more ran about on the ground. Three or four amazons were out and less active, having almost nothing to do with the sexed individuals. But perhaps the most interesting thing to note about the nuptial flight was the almost complete suspension of excavating activity, only about six earth pellets being brought out by the very large number of slaves on the nest during the half hour they were under my observation. Quite in contrast with this was the great increase in the amount of food being brought in.

It was rushed right down the nest hole, over amazons, slaves and sexed ants. One arrival was a fly; another a round, green bug about three eighths of an inch long, being convoyed by four slaves; and another a worm an inch and a half long under control of three others. Of the latter three, each seemed to be desirous to bring it in alone as her particular booty. At one moment, one slave suddenly and swiftly backed up a grass stem with the worm dangling in mid-air with her chief competitor dangling from the worm, while the third ant was left on the ground till the others came down again. But the second had not been gotten rid of so easily by this act, for she continued to hold on desperately.

August 11. Up to this date, when camp was broken, the ants did not go out on another slave raid so far as I could discover, although I kept daily watch on them except in stormy weather. However, a few amazons were seen outside of the nest on a few occasions. A few more fitful indications of swarming took place, two or more winged ants being out this day, but none were seen to fly away. The swarming above noticed (July 22) followed so soon on the heels of the slave raid (July 21) that I am inclined to ask if the time of swarming can be conditioned by a slave raid, or attendant to it? Further, what has the sudden foray to do with the swarming instinct? One thing seemed to me fairly clear — that after as successful an expedition as the one here described this species of ants does not foray as frequently as the *sanguineas*, which would seem to indicate a quicker satisfying of this interesting instinct.

NOTES ON NORTH AMERICAN SPECIES OF CRASSISETA V. ROS.

BY C. F. ADAMS,

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At various times the species of this genus have been catalogued and listed under either *Crassiset*a or *Elachiptera*, and of late American students have considered these two generic terms synonymous, giving the latter priority. Bezzi (Contribuzione alla Fauna Ditterologica Italiana, I, pp. 33-34, 1895) reserves the name *Elachiptera* for *brevipennis* Mg., and *Crassiset*a for the remaining species. The Ital-